

MULTIMEDIA



UNIVERSITY

STUDENT ID NO

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# MULTIMEDIA UNIVERSITY

## SUPPLEMENTARY EXAMINATION

TRIMESTER 1, 2015/2016

**TIF 2721/TSE 2351 – INTRODUCTION TO FORMAL  
METHODS**  
( All sections / Groups )

18 NOV 2015  
2.30 PM – 4.30 PM  
(2 HOURS)

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### INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages with 5 Questions only, excluding the cover page.
  2. Attempt **FOUR** out of **FIVE** questions. All questions carry equal marks and the distribution of the marks for each question is given.
  3. Please print all your answers in the Answer Booklet provided.
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**Question 1** (4 + 2 + 4 marks)

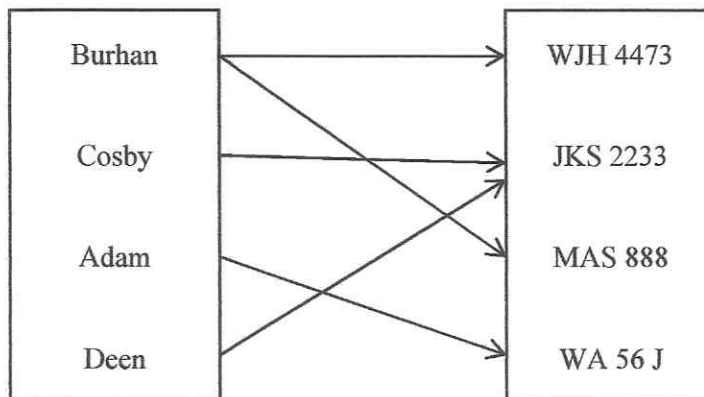
a. List all the elements of the following:

- i.  $\mathbb{P} \{2, 4\}$
- ii.  $\mathbb{P} \mathbb{P} \emptyset$
- iii.  $\{1\} \times \{2, 3\}$
- iv.  $\{n: \mathbb{Z} \mid n > 0 \wedge n < 10 \wedge n \bmod 2 = 0\}$

b. “Existing applications of formal methods include: the use of probability theory in performance modeling; the use of context-free grammars in compiler design; the use of the relational calculus in database theory.”

What are the advantages of the application of mathematics in formal specification?

c. Examine the relation *driver\_assignment* below:



- i. What are the ordered pairs of the relation?
- ii. What is the range of the relation?
- iii. What is  $driver\_assignment^{-1}(\{MAS\ 888\})$ ?
- iv. Is the relation a function? Explain.

Continued .....

**Question 2** (4 + 2 + 4 marks)

- a. You are given two Z schemas  $A$  and  $B$  as defined below. Construct  $A \wedge B$ . Show all the necessary steps.

$$A \triangleq \left[ \begin{array}{l} c, d : \mathbb{N} \\ E : \mathbb{P} \mathbb{Z} \\ | \\ c < d \end{array} \right]$$

$$B \triangleq \left[ \begin{array}{l} c, f : \mathbb{Z} \\ S : \mathbb{P} \mathbb{N} \\ | \\ c > f * 13 \end{array} \right]$$

- b. What is schema composition? Why is schema composition useful?
- c. You are given two Z schemas  $M$  and  $P$  as defined below. Construct  $M;P$ . Show all the necessary steps.

$$M \triangleq \left[ \begin{array}{l} x!, s, s', y! : \mathbb{N} \\ | \\ s' = s - x! ; \\ s = y! \end{array} \right]$$

$$P \triangleq \left[ \begin{array}{l} x?, s, s' : \mathbb{N} \\ | \\ s < x? ; \\ s' = 17 - s \end{array} \right]$$

Continued .....

**Question 3** (1 + 3 + 3 + 3 marks)

A tuition center is attempting to design a system that keeps track of the tutors and classes in the center. A *tutor* may teach many classes and a *class* is taught by various tutors.

- a. Define two types: *Person* is the set of all people. *Class* is the set of all classes.
- b. Specify a state schema for the system called *Tuition*. The state schema must include the following state information:
  - The set of all classes in the tuition center (*allClasses*)
  - The set of all registered tutors in the tuition center (*allTutors*)
  - The relation called *assign*, which models the relation between tutors and classes they teach

Include two appropriate state invariants for the state schema.

- c. Specify (using Z notation) an operation called *Assignment* that adds a registered tutor to a class.
- d. Specify (using Z notation) an operation called *SearchTutor*, which given a class name (*cls?*), displays the set of tutors for the class (*tutors!*).

**Continued .....**

**Question 4** (4 + 3 + 3 marks)

- a. The following table shows the number of students categorized by their ethnicity in a school.

Ethnic	Number of students
Malay	72
Chinese	69
Indian	65
Others	29

The table above can be represented (in Z notation) using a bag. Specify a function (in Z notation) that returns the total number of students in the school.

- b. Three sequences,  $X$ ,  $Y$  and  $Z$  are defined as follows:

$$\begin{aligned}X &= \langle 9, 7, 5, 3, 1 \rangle \\Y &= \langle 10, 20, 30 \rangle \\Z &= \langle 34, 76, 90, 45 \rangle\end{aligned}$$

Find the following:

- $\text{head}(X) \hat{\ } \text{tail}(Y)$
  - $\text{dom}(Z \hat{\ } X)$
  - $\text{rev}(Y \hat{\ } Z)$
- c. What is data reification? Describe the importance of data reification in formal specification.

Continued .....

**Question 5** (3 + 4 + 3 marks)

a. Determine if the following Hoare triples are true or false. Substantiate your answer.

i.  $\{n \geq 0\} \wedge (n^2 > 28) \{m := n + 1; m := m * m \{m \neq 36\}$

ii.  $\{x = y\} \text{ if } (x = 0) \text{ then } x := y + 1 \text{ else } z := y + 1 \{(x = y + 1) \vee (z = x + 1)\}$

iii.  $\{true\} x := y + 1 \{z = 1\}$

b. One of the processes in developing and using formal specification is to carefully divide specifications among broad classes, such as functionality, operations, behavior and interface.

Give a short description on the four classes: functionality, operations, behavior and interface.

c. “Formal specifications serve only to clearly state system requirements.”

i. Describe why software developers must maintain high-level abstraction.

(2 marks)

ii. List four aspects which should not be included in formal specification to maintain high-level abstraction.

(1 mark)

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